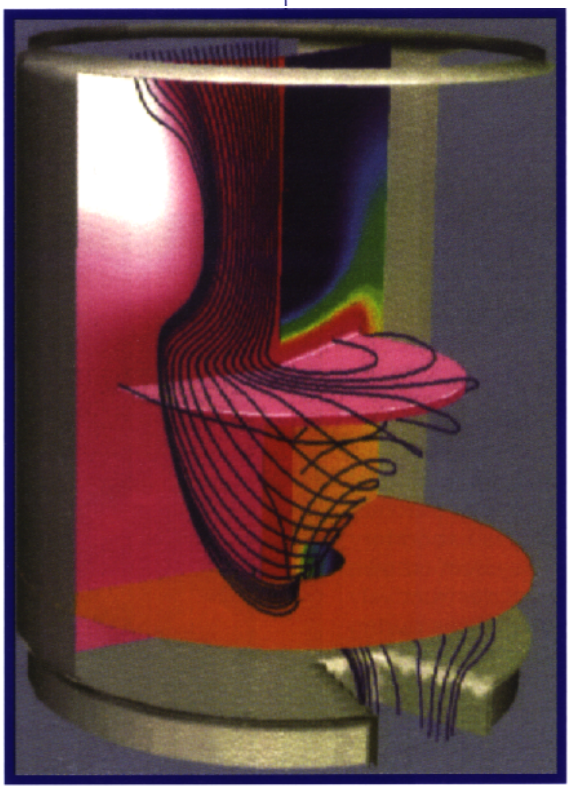
Chemical Processing

chemistry in our daily lives

Proessing technologies involving chemicals affect how we live in a number of ways, from growing and preparing foods, to generating energy, to manufacturing cars and semiconductors. Understanding and improving these processes are challenging multidisciplinary problems. BES research is providing the scientific underpinning needed for chemical processing technologies that meet the demands of both industry and society: high quality with minimal environmental impact, minimum cost, and maximum efficiency.

The quality of industrial processes — whether pharmaceutical manufacturing or environmental analysis — hinges on simple and effective mixing of ingredients. Basic chemical research in BES-supported laboratories has provided new approaches that have raised mixing efficiencies more than tenfold.

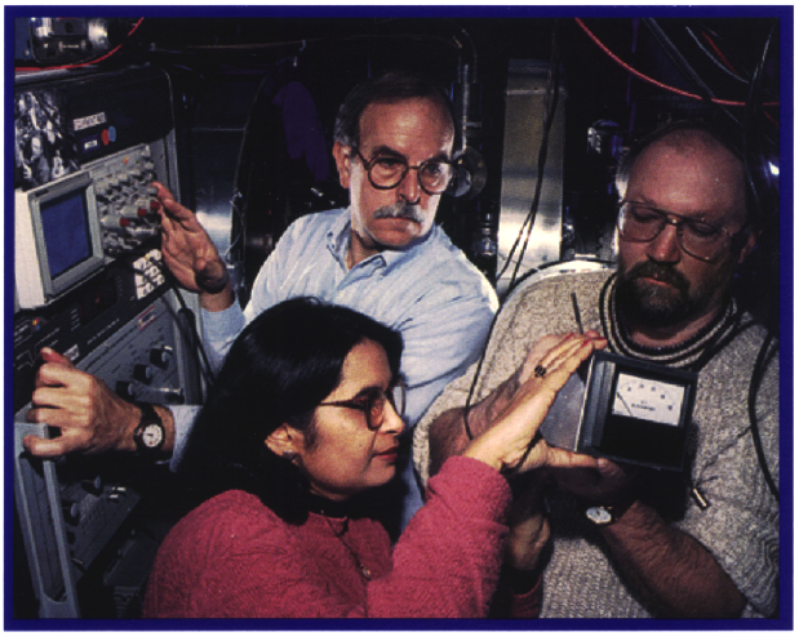
Most chemical processes take place in containers and involve transporting liquids or gases through pipes and other conduits. BES research, a major contributor to chemical processing, is helping to control corrosion through coatings and solution chemistry. BES innovations include microscopic coatings for enzymes and catalysts to protect them from harsh industrial environments, thereby extending their lifetime and effectiveness.



Various industries are using a computer model such as this one, developed to study the fundamental chemical interactions that occur during chemical vapor deposition (CVD). CVD is an important technological processing technique used in fabricating semiconductors and other types of thin films. Since 1990, Sandia National Laboratories has distributed more than 200 copies of this modeling software, called "Surface Chemkin," under a no-fee licensing agreement. This model shows the profiles of the chemical species and thermal gradients in an Emcore CVD epitaxial growth reactor.

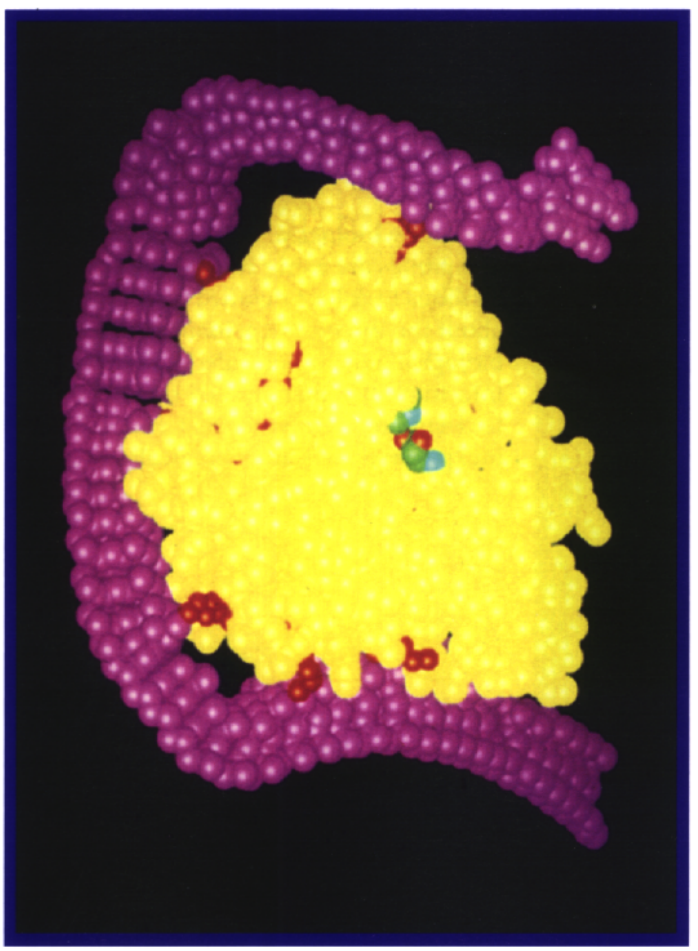
Today, industry is moving toward computer design of chemical processes. BES models of chemical interactions are playing a key role in this activity. Industries are already using models of gas-surface reactions to guide and control combustion reactions and a host of industrial chemical processing and environmental abatement technologies.

BES researchers and user facilities are also working with industry using advanced characterization techniques to identify defects that limit lifetimes of catalysts, paints, and a wide range of related products. Correlating these microscopic features with controlled variations in processing and operational conditions is challenging, but it is leading to enhanced understanding — and hence, improving — process chemistry.



Analyzing Coatings

A real challenge to the paint and building industries is determining the lifetimes of painted surfaces exposed to weathering. Brookhaven and Oak Ridge National Laboratories, working with the Masonite Corporation, have developed a new technique that allows the effects of weathering to be detected and characterized. Using positron annihilation techniques, researchers detected defects in painted surfaces after only one week of weathering. Earlier techniques required a minimum of one year exposure before defects could be detected. This photo shows the positron annihilation facility at Brookhaven.



Protecting Enzyme Catalysts

Enzymes valued at billions of dollars per year are used as catalysts in industrial processes, in pharmaceuticals, and as specialty chemicals. Lawrence Berkeley National Laboratory has developed a novel carbohydrate-based polymer, Carbohydrate Protein Conjugate, that stabilizes a wide variety of proteins, including enzymes and antibodies. The polymer does this by wrapping around the protein surface and providing a unique and stabilizing microenvironment. The coatings allow enzymes to remain active in hostile industrial environments and prolong their useful lifetimes. This material, developed in conjunction with Cargill Incorporated, was the winner of an R&D 100 Award and is now commercially available from Sigmachemical Company.